(12) UK Patent Application (19) GB (11) 2 330 930 (13) A

(43) Date of A Publication 05.05.1999

(21) Application No 9820556.0

(22) Date of Filing 21.09.1998

(30) Priority Data
(31) 08936336 (32) 24.09.1997 (33) US

(51) INT CL[6]
G06F 17/30

(52) UK CL (Edition Q)
G4A AUDB

(56) Documents Cited
EP 0722145 A1 EP 0631245 A2 EP 0601759 A1
WO 95/12173 A1

(58) Field of Search
UK CL (Edition Q) G4A AUDB
INT CL[6] G06F 17/30

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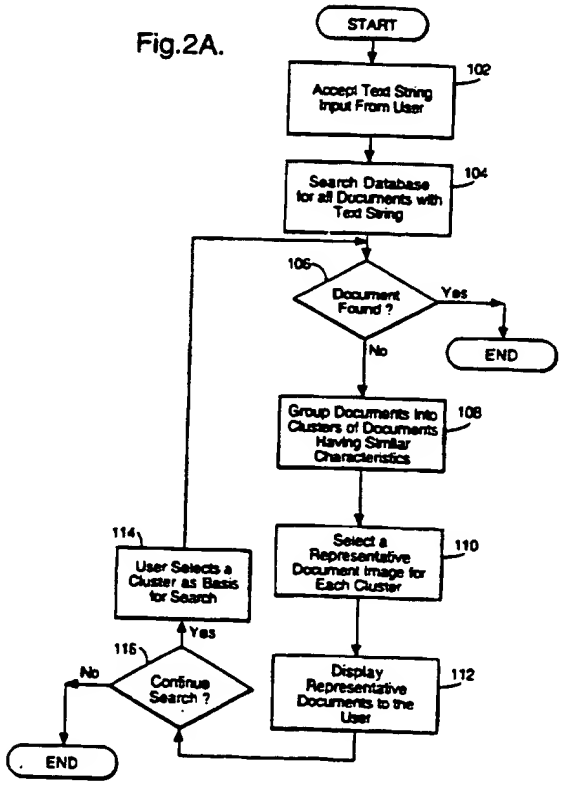
(54) Abstract Title
Navigation system for document database

(57) An interactive database organization and searching system employs text search and image feature extraction to automatically group documents together by appearance. The system automatically determines visual characteristics of document images and collects documents together according to the relative similarity of their document images.

Fig.2A.



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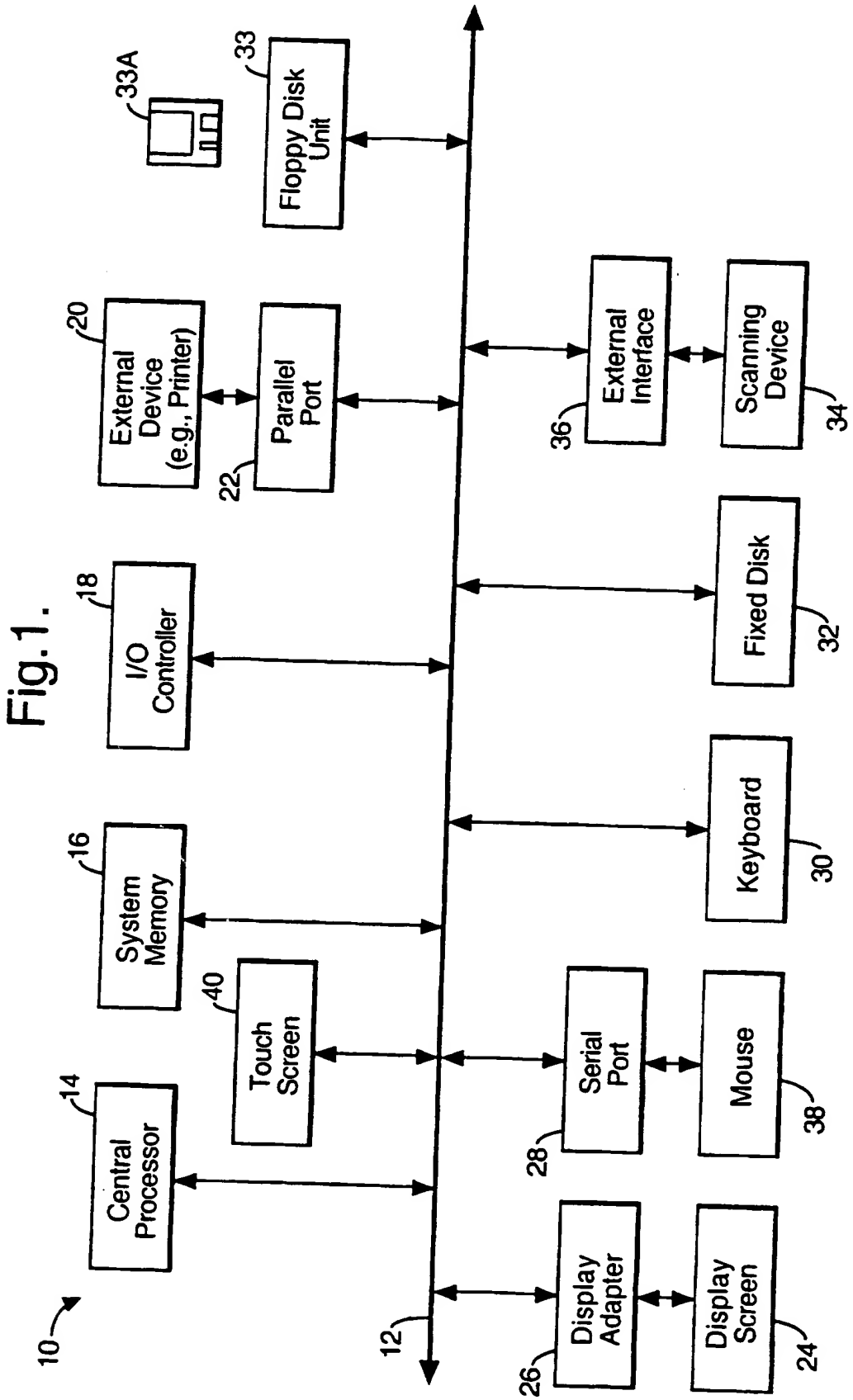

10
12
Central Processor
14
System Memory
16
I/O Controller
18
External Device (e.g., Printer)
20
Parallel Port
22
Display Adapter
26
Display Screen
24
Touch Screen
40
Serial Port
28
Mouse
38
Keyboard
30
Fixed Disk
32
External Interface
36
Scanning Device
34
Floppy Disk Unit
33
33A

Fig.1.

Fig.2A.

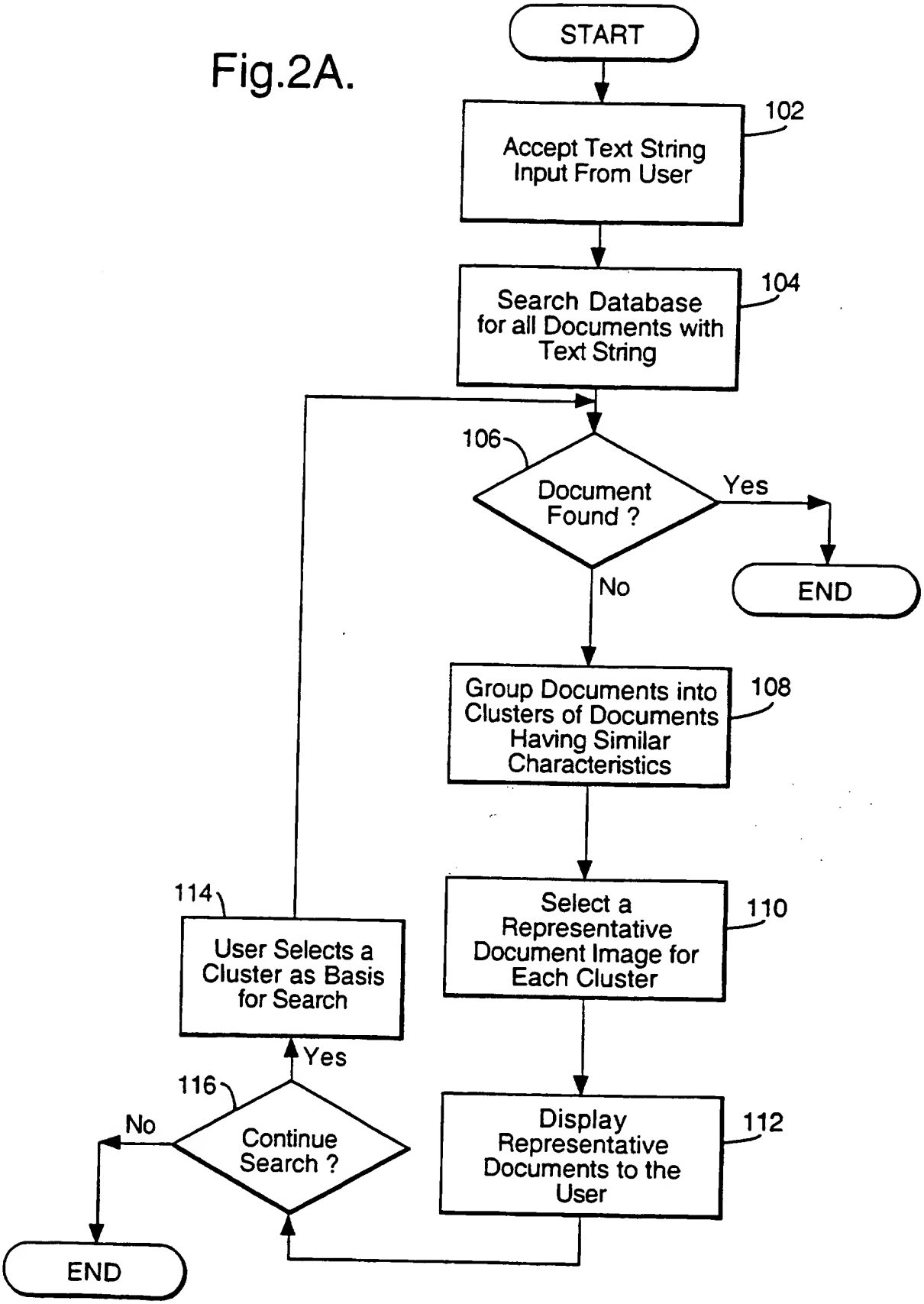

START
Accept Text String Input From User
102
Search Database for all Documents with Text String
104
106
Document Found ?
Yes
END
No
Group Documents into Clusters of Documents Having Similar Characteristics
108
Select a Representative Document Image for Each Cluster
110
Display Representative Documents to the User
112
114
User Selects a Cluster as Basis for Search
Yes
116
Continue Search ?
No
END

Fig.2B.

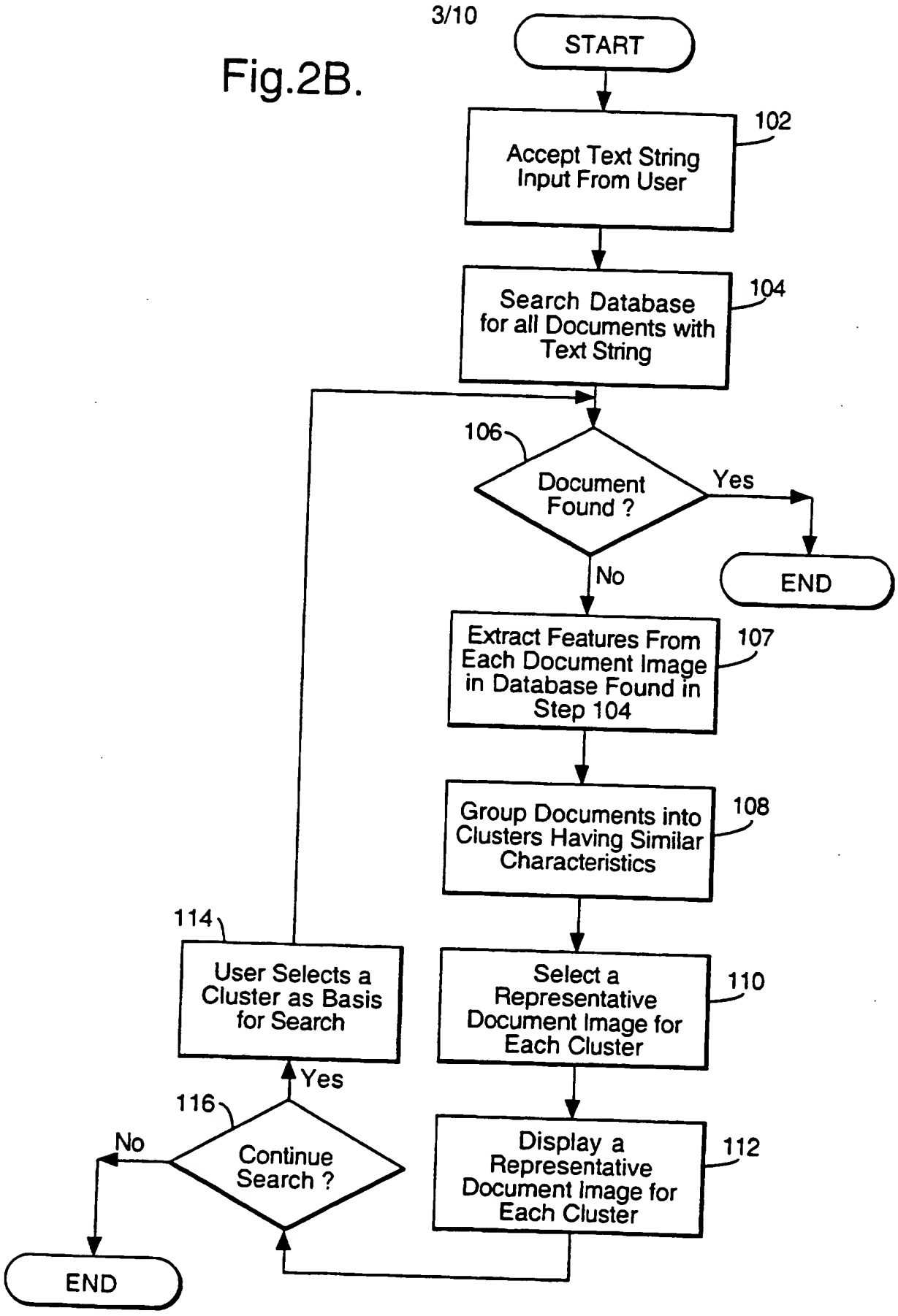

START
Accept Text String Input From User
102
Search Database for all Documents with Text String
104
106
Document Found ?
Yes
No
END
Extract Features From Each Document Image in Database Found in Step 104
107
Group Documents into Clusters Having Similar Characteristics
108
Select a Representative Document Image for Each Cluster
110
Display a Representative Document Image for Each Cluster
112
114
User Selects a Cluster as Basis for Search
116
Continue Search ?
Yes
No
END

Fig.3A.

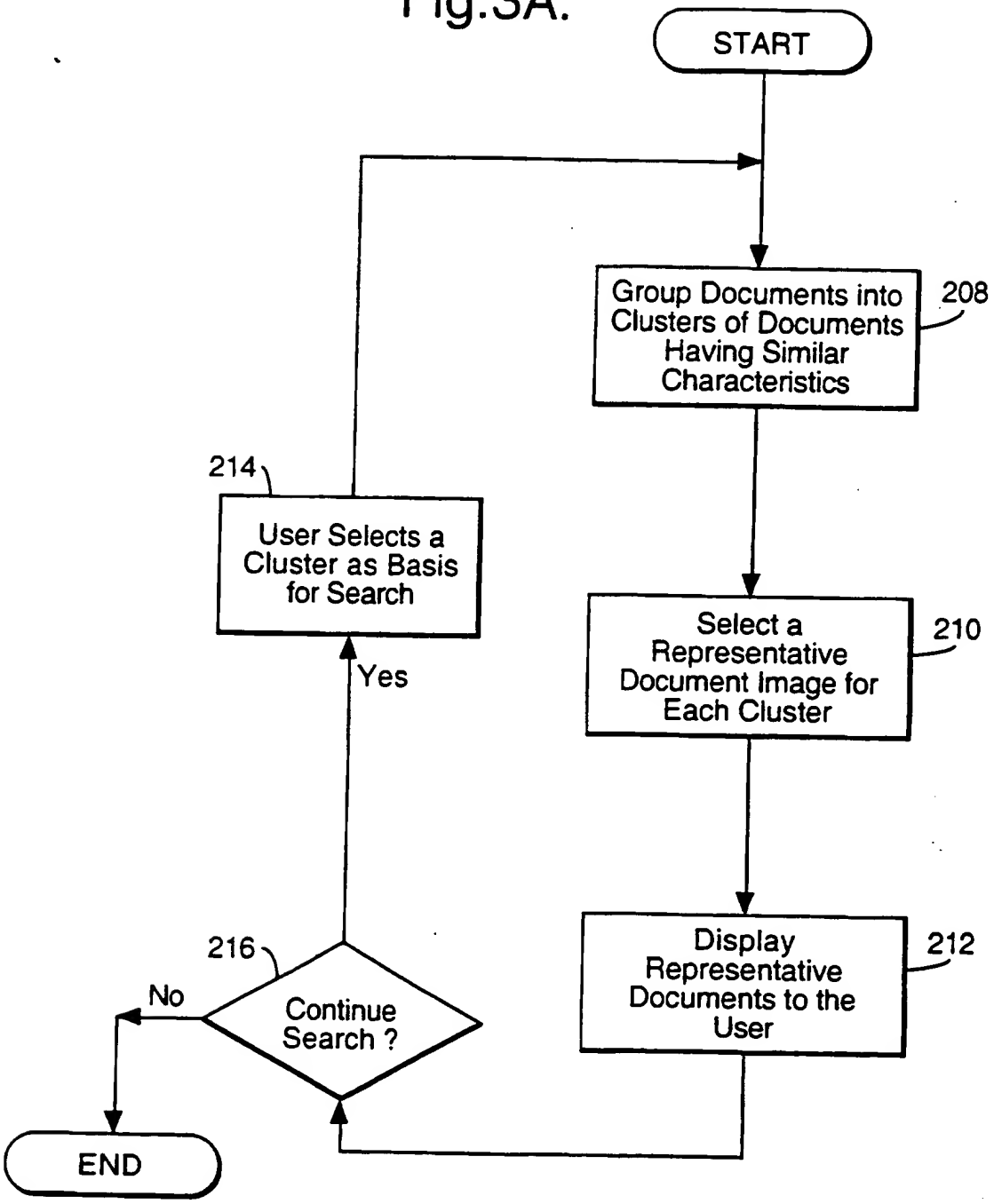

START
Group Documents into Clusters of Documents Having Similar Characteristics
208
Select a Representative Document Image for Each Cluster
210
Display Representative Documents to the User
212
Continue Search ?
216
No
Yes
User Selects a Cluster as Basis for Search
214
END

Fig.3B.

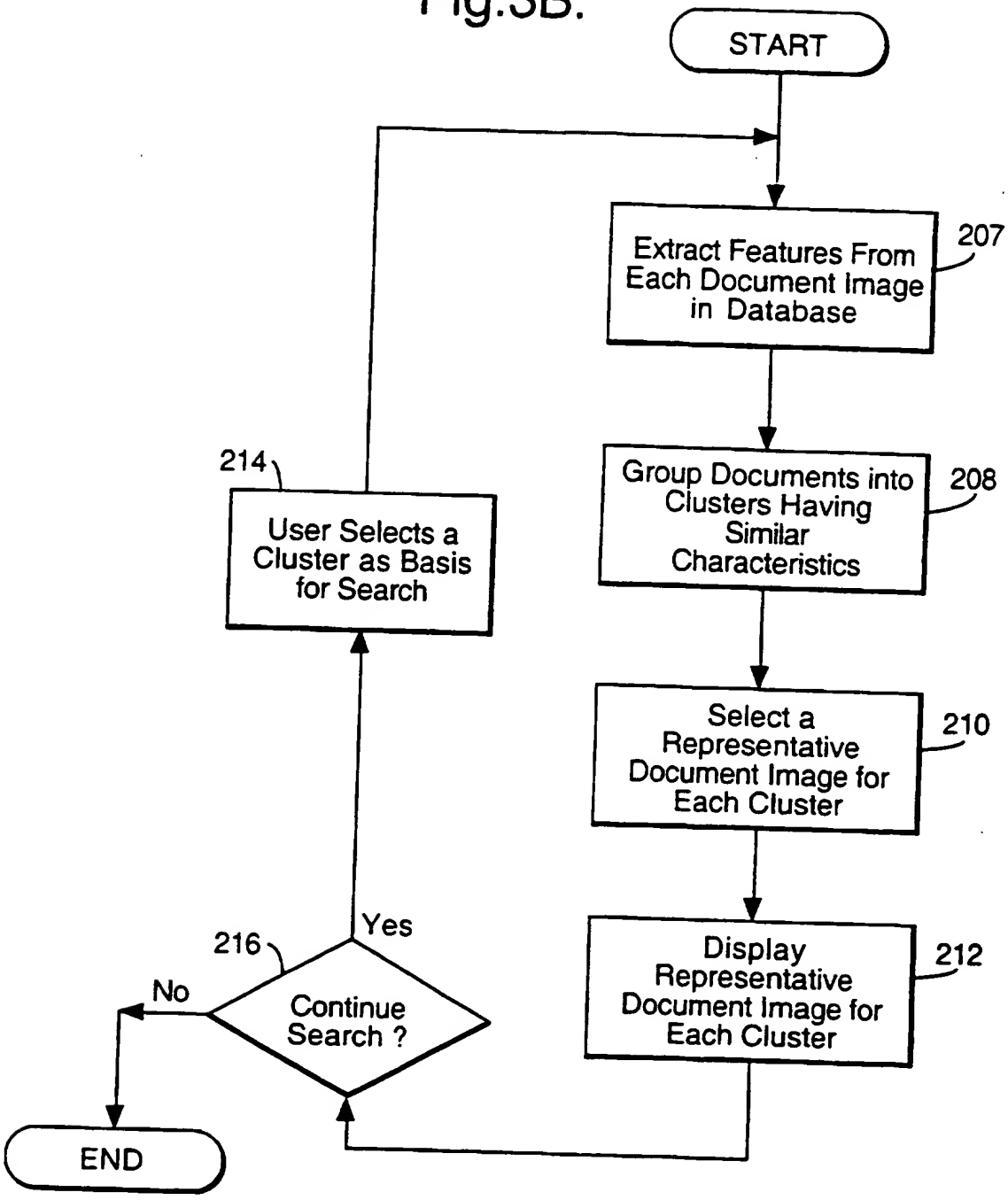
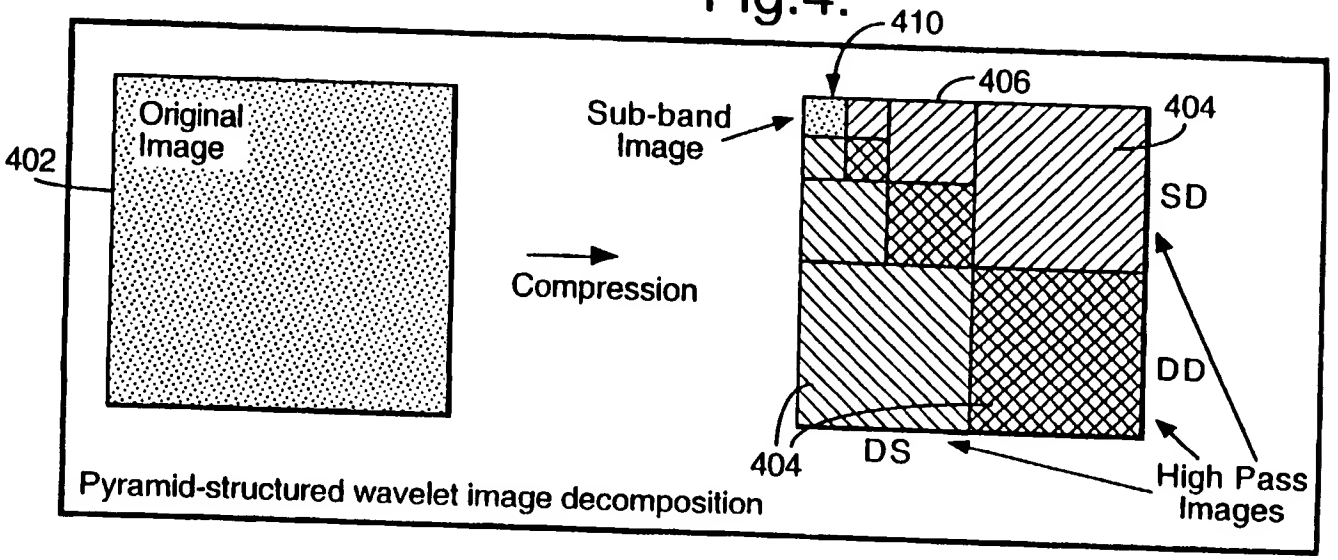
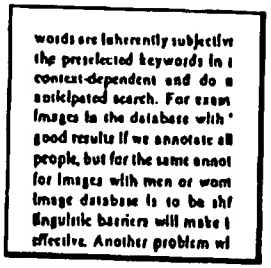

START
Extract Features From Each Document Image in Database
207
Group Documents into Clusters Having Similar Characteristics
208
Select a Representative Document Image for Each Cluster
210
Display Representative Document Image for Each Cluster
212
Continue Search ?
216
Yes
No
User Selects a Cluster as Basis for Search
214
END

Fig.4.



Before Compression



After Uncompression 20:1

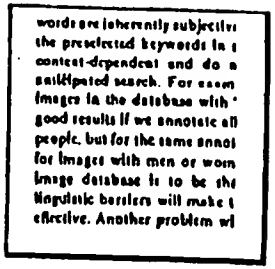


Fig.5.

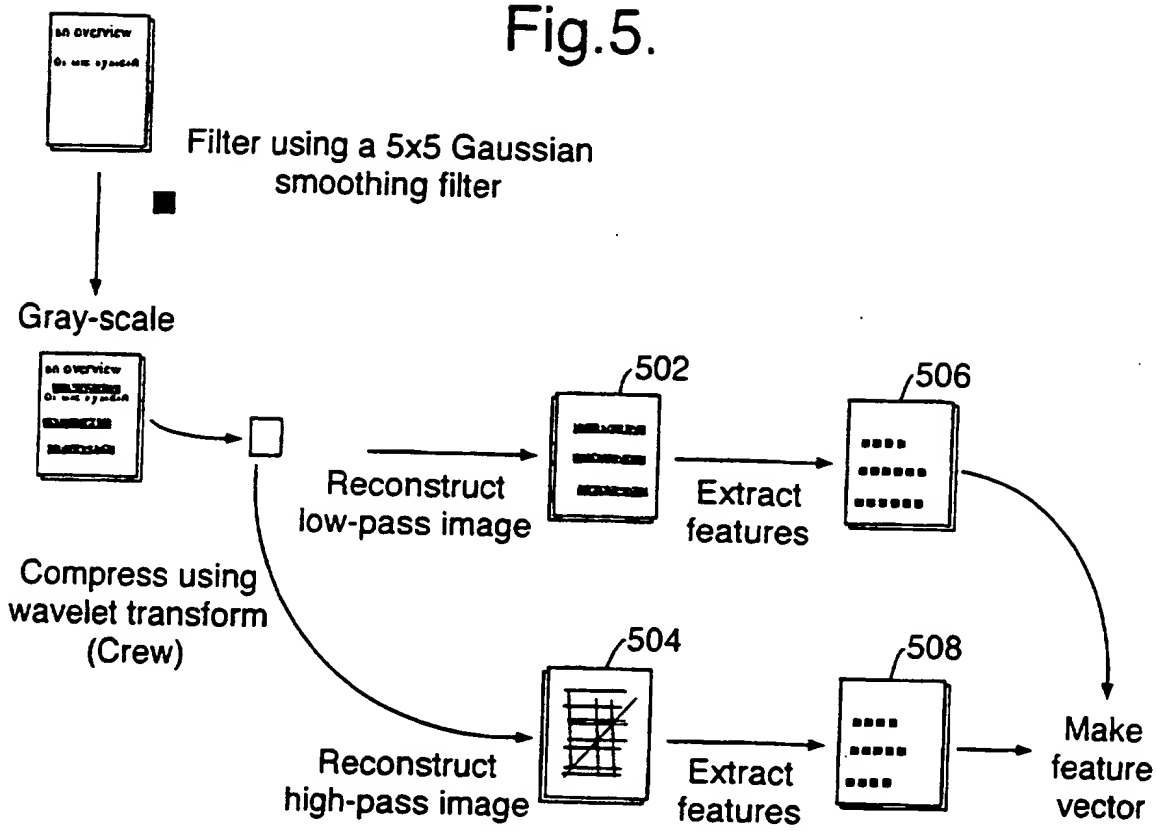
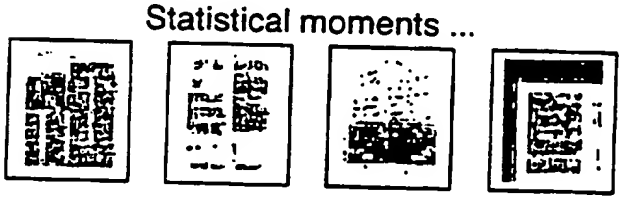


Fig.6.



Consider a pixel values: X_1 .....X_N

$$X_{mean} = \frac{1}{N}\sum_{j=1}^{N} X_j$$

$$X_{variance} = \frac{1}{(N-1)}\sum_{j=1}^{N} (X_j - X_{mean})^2$$

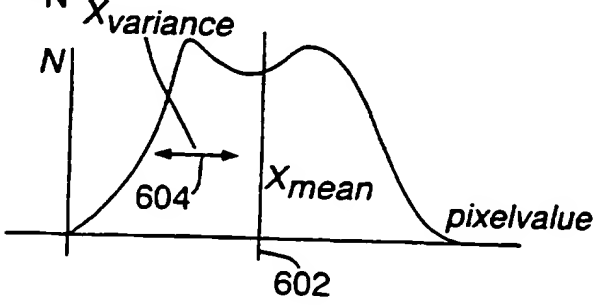


Fig.7.

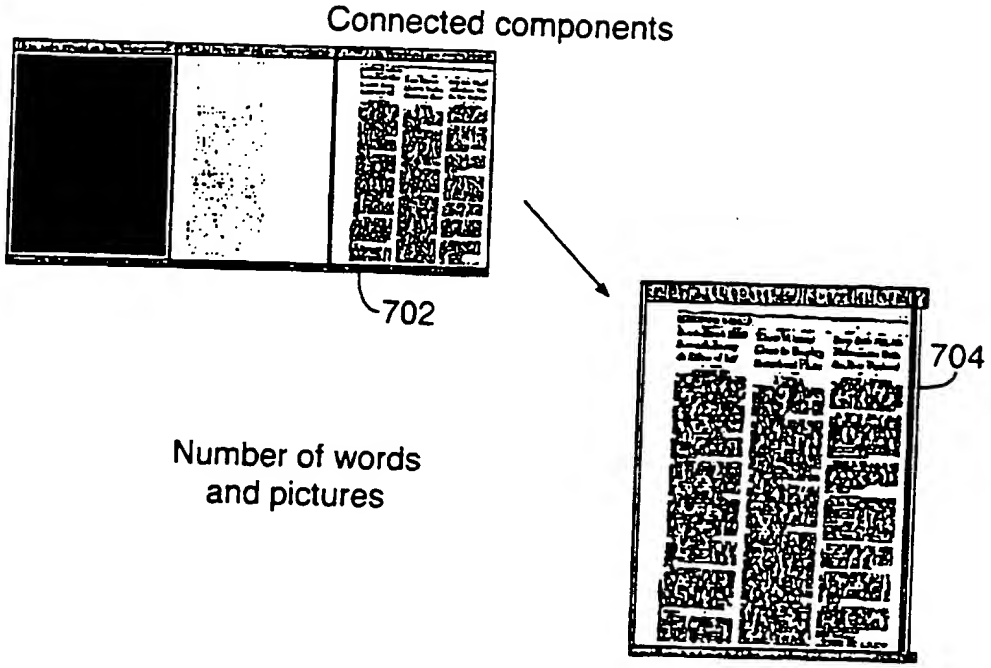
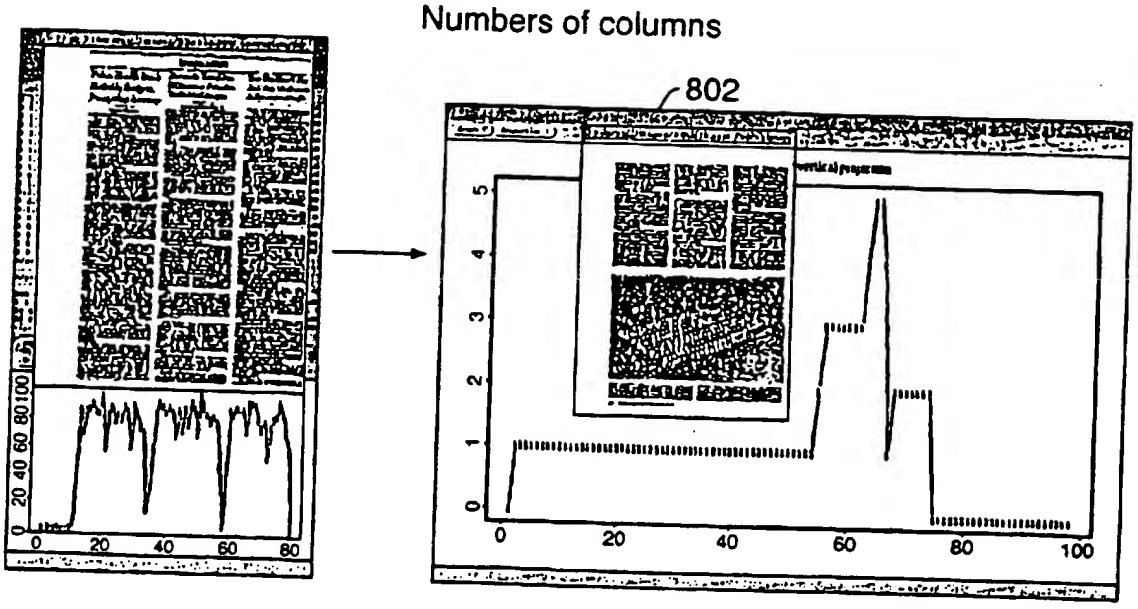

Connected components
702
704
Number of words
and pictures

Fig.8.


Numbers of columns
802
0 20 40 60 80 100
0 1 2 3 4 5
0 20 40 60 80

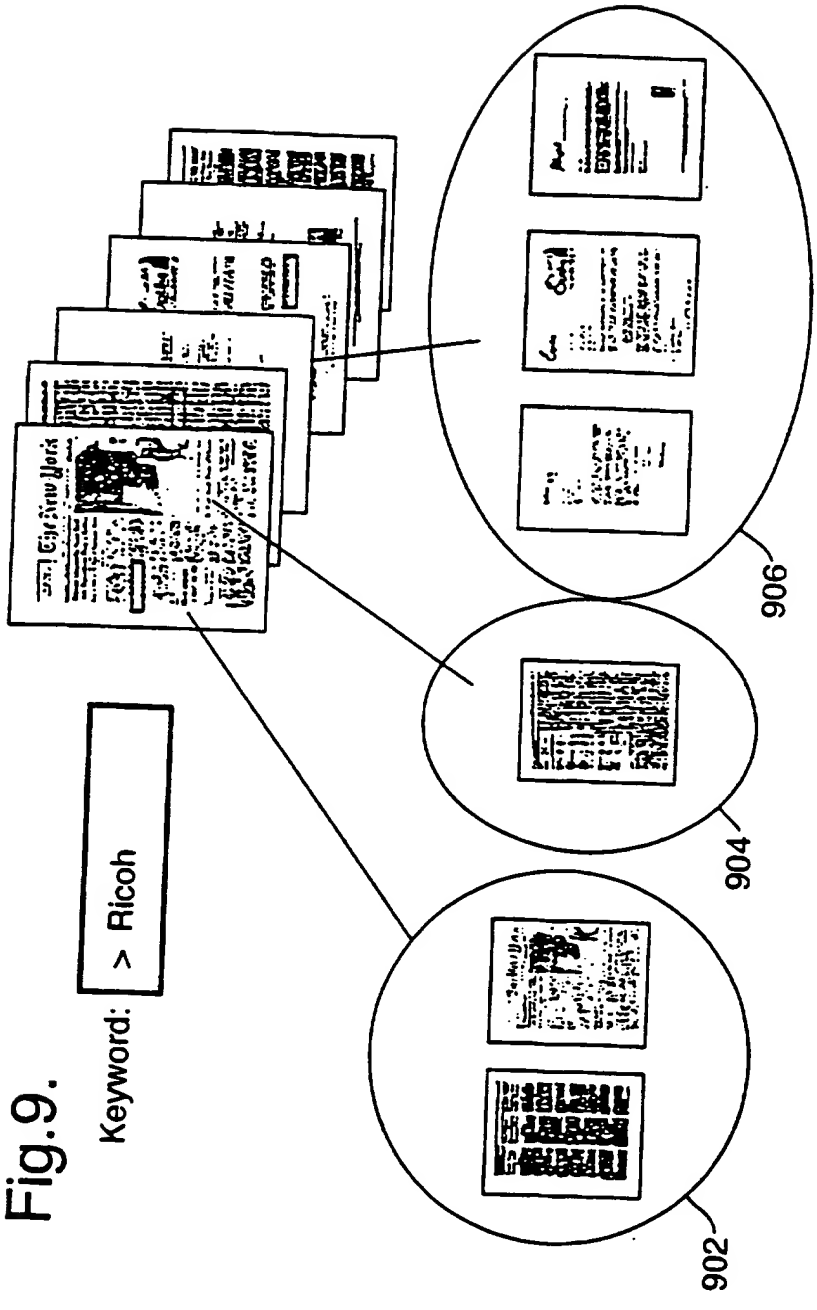


Fig.9.

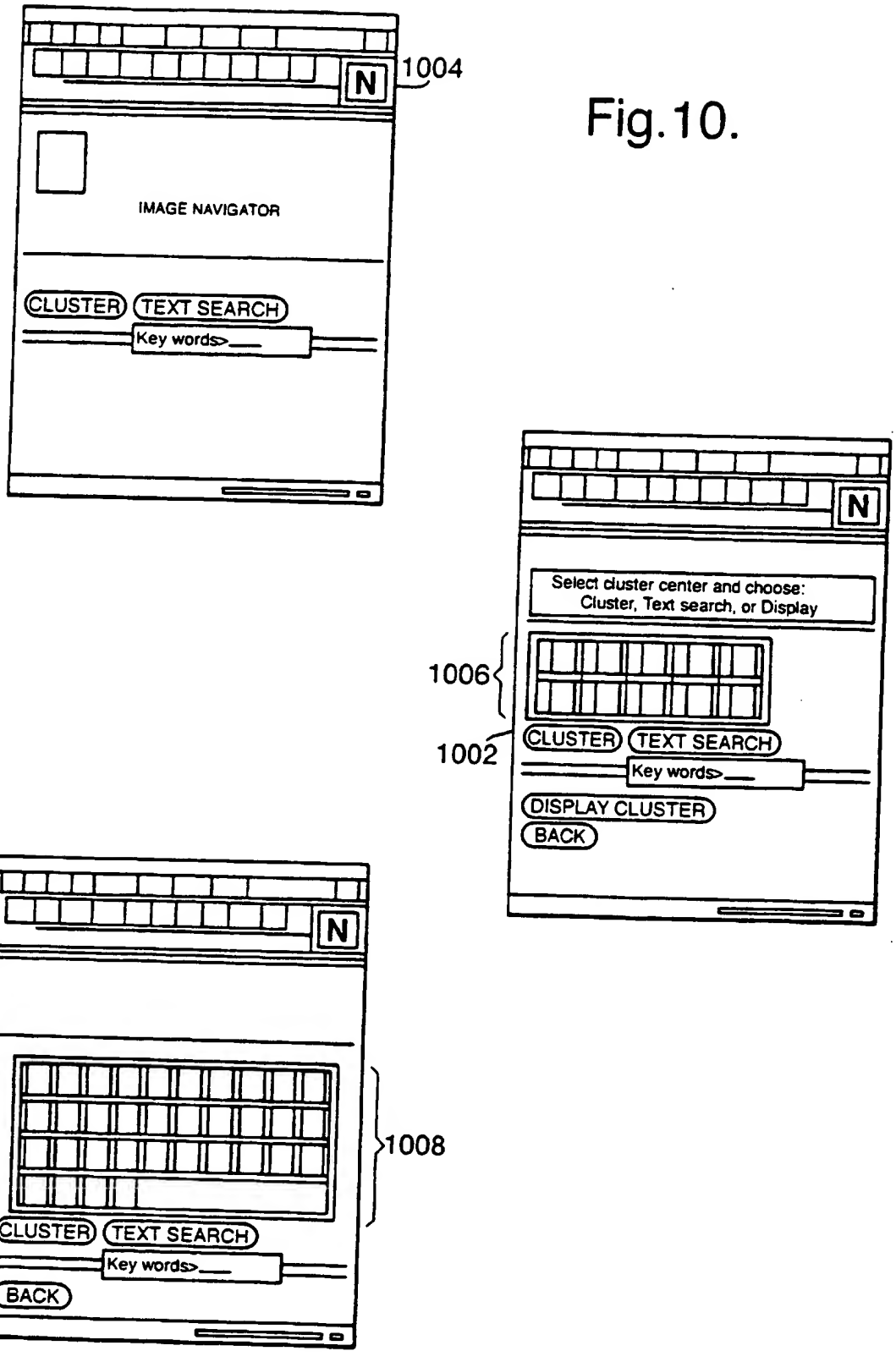

N
1004
IMAGE NAVIGATOR
CLUSTER
TEXT SEARCH
Key words>
Select cluster center and choose:
Cluster, Text search, or Display
1006
1002
CLUSTER
TEXT SEARCH
Key words>
DISPLAY CLUSTER
BACK
N
1008
CLUSTER
TEXT SEARCH
Key words>
BACK

Fig.10.

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NAVIGATION SYSTEM FOR DOCUMENT IMAGE DATABASE

This invention relates to document management systems and more particularly to providing a method of navigating through a database of document images.

The proliferation of low-cost, high-capacity electronic storage of document images has enabled users to keep ever increasing amounts and varieties of documents, previously stored in hard copy format, as electronic information online. While this revolution in storage technology has reduced the cost of document storage, it brings with it the need for more efficient methods of searching through a myriad of online documents to find a particular document or set of documents of interest to the user.

Methods for locating a document of interest have been rudimentary at best. Typically, in these methods, documents are scanned into the computer and an Optical Character Recognition ("OCR") program converts the image into a textual file. Next, a form of keyword matching search is performed, with the system either scanning the entire text of all documents, or a set of carefully chosen keywords thought to be representative of the document by a person who initially classified the document.

The problem with the first approach is the high search cost involved with traversing a large number of documents in their entirety. The difficulty with the second approach is that different persons will employ different strategies to filing and retrieval. As the heterogeneity of documents contained in databases increases, the reliability of these traditional search methods diminishes.

Recognizing the opportunity to exploit the information content of the image portion of documents, several attempts have been made to search for documents based upon matching of small images contained in the documents. For example, M.Y. Jaisimha, A. Bruce and T. Nguyen in their work, "DocBrowse: A system for Textual and Graphical Querying on Degraded Document Image Data" describe a system which searches for documents based upon company logos in letterheads. D. Doermann, et. al. in "Development of a General Framework for Intelligent Document Retrieval," outline a system for matching documents based upon generation and matching of an image descriptor which describes low-level features and high-level structure of a document. Unfortunately, this method requires intensive processing of the image information, which greatly

curtails its use in most commercial applications.

While such methods provide document search capability via elemental matching of image characterization vectors, they do not provide a useful method to organize a large database of document images. These and other shortcomings indicate that what is needed is a method and system for efficiently searching a database of document images. This method would expedite search by organizing the database according to the textual as well as the visual characteristics of document images.

The present invention provides an interactive database organization and searching system which employs text search and image feature extraction to automatically group documents together by appearance. The system automatically determines visual characteristics of document images and collect documents together according to the relative similarity of their document images.

One representative embodiment is a method that includes the steps of accepting from the user a textual string keyword to serve as the basis for an initial search, searching the textual component of

document images in the database for the keyword, grouping document images having textual components which contain the keyword into clusters of document images based upon processing of the features extracted from compressed representations of the document images, displaying a representative document image for each cluster of document images, and accepting input from the user indicating a particular cluster of document images upon which the system may perform further search.

Another representative embodiment is a method that includes the steps of grouping document images together based upon feature information to form clusters of document images having similar feature characteristics, selecting a representative document image from each cluster of document images, displaying the representative document image to the user, and accepting input from the user to select a cluster of images upon which the system may perform further search.

A related embodiment extracts feature information from the compressed image prior to performing the grouping steps described above. Another related embodiment also permits the user to specify a desired number of clusters.

The invention will be better understood by reference to the following detailed description in connection with the following drawings, in which:

Fig. 1 depicts a representative computer system suitable for implementing the invention.

Fig. 2A depicts a flowchart describing a representative querying operation of the database in a preferable embodiment of the invention.

Fig. 2B depicts a flowchart describing a representative querying operation of the database in an alternative embodiment of the invention.

Fig. 3A depicts a flow chart of the steps performed in organizing the database in an alternate preferable embodiment of this invention.

Fig. 3B depicts a flow chart of the steps performed in organizing the database in an alternate embodiment of this invention.

Fig. 4 depicts the use of compression on a document image to facilitate low cost storage and expedient manipulation of image components by the system.

Fig. 5 depicts extraction of image feature information from compressed images to serves as the

basis for image grouping.

Fig. 6 depicts extraction of statistical moments from low frequency image information.

Fig. 7 depicts extraction of connected components of number of words and number of pictures from high frequency image information.

Fig. 8 depicts extraction of connected components of number of columns from high frequency image information.

Fig. 9 depicts the clustering of document images aspect of the invention.

Fig. 10 depicts the use of a web browser to implement the display and user interface portions of the invention.

Representative System Suited to Practice the Invention

In a typical installation, the invention will be practiced on a computer system with the basic subsystems such as depicted in Fig. 1. In the representative system of Fig. 1, a computer system 10 includes bus 12 which interconnects major subsystems such as central processor 14, system memory 16,

input/output (I/O) controller 18, an external device such as a printer 20 via parallel port 22, display screen 24 via display adapter 26, serial port 28, keyboard 30, fixed disk drive 32 and floppy disk drive 33 operative to receive a floppy disk 33A. Many other devices can be connected such as scanning device 34 connected via external interface 36, mouse 38 connected via serial port 28 and touch screen 40 connected directly. Many other devices or subsystems (not show) may be connected in a similar manner. Also, it is not necessary for all of the devices shown in Fig. 1 to be present to practice the present invention, as discussed below. The devices and subsystems may be interconnected in different ways from that shown in Fig. 1 without impairing the operation of the system. The operation of a computer system such as that shown in Fig. 1 is readily known in the art and is not discussed in detail in the present application. Source code to implement the present invention may be operably disposed in system memory 16 or stored on storage media such as fixed disk 32 or floppy disk 33A. An image database may also be stored on fixed disk 32.

Display screen 24 is similar to that in use on standard computers such as personal computers,

workstations or mainframe computers employing a CRT screen or monitor. Various forms of user input devices may be used with the present invention. For example, a mouse input device 38 that allows a user to move a pointer displayed on the display screen in accordance with user hand movements in a standard user input device. A mouse usually includes one or more buttons on its surface so that the user may point to an object on the screen by moving the mouse and may select the object, or otherwise activate the object, be depressing one or more buttons on the mouse. Alternatively, a touch screen allows a user to point to objects on the screen to select an object and to move the selected object by pointing to a second position on the screen. Various buttons and controls may be displayed on the screen for activation by using the mouse or touch screen. Fixed disk drive 32 may be a hard disk drive or an optical drive or any medium suitable for storing a database of document images.

Overview of Querying Operation Performed on the Image Database

One unique and innovative feature of this invention is the intuitive manner in which image based search can be conducted on the documents in the

database without requiring the user to build a representative document image as is required in the art. See Japanese Laid-Open Patent Application No. 9-237282, which corresponds to U.S. Patent Application S.N. 08/431,059, entitled, "Image Database Browsing and Query Using Texture Analysis".

In one particular embodiment of the invention depicted in Fig. 2A, the textual portion of documents is extracted from document images using OCR scanning and is made available in the database. This database can reside in any or multiple storage media in the computer system, such as the fixed disk 32 or system memory 16. The search procedure commences with an initial query step 102, in which the user inputs one or more keywords (i.e. text string or a combination of text strings) into the system via an input device such as terminal keyboard 30 and display screen 24.

Searching proceeds for the text string in the textual portions of the documents contained in the database in text based search step 104. If the text based search yields the document of interest, then the user may discontinue any further processing in step 106. Otherwise, documents containing the text string become the basis for image based search. In a

preferred embodiment, features extracted from compressed representations of document images are available in the database. Documents meeting the text based search are grouped together in grouping step 108 to form clusters based upon similarity of the features extracted from each document image. A representative document image is selected in step 110 for each cluster of document images formed in the grouping step 108.

The representative document images are displayed to the user on the display 24 in display step 112. In a preferable embodiment, as depicted in Fig. 4, a compressed representation of each representative document image is displayed as an icon 402 using a web browser 404 as a user interface. A related embodiment displays uncompressed representative images. In the preferable embodiment, the user may select a particular cluster as the basis for further search by indicating to the system, with a mouse 38 or other input device, the representative document icon for the cluster which is to be the basis of further search as in step 114.

Search proceeds by applying the grouping step to the selected cluster of documents, sub-dividing this cluster into a new set of clusters 108,

each having a new representative document image. Search continues until either the document is found 106, or the user chooses to discontinue the search 116.

In a related embodiment depicted in Fig. 2B, a compressed representation of each document image is made available in the database. Features are extracted from these compressed representations in an extraction step 107, interposed between document complete step 106 and grouping step 108. Search proceeds with grouping step 108 as in the prior embodiment.

Another related embodiment also includes the step of permitting the user to choose the number of clusters desired before the first grouping step 108, or at any time while navigating the database prior to a new application of the grouping step.

An alternative embodiment of the invention is depicted in Fig. 3A. As in the embodiment discussed above features extracted from compressed representations of document images are preferably available in the database. Documents are grouped together to form clusters in grouping step 208 based upon similarity of the features extracted from each document image. A representative document image is

selected in step 210 for each cluster of document images formed in the grouping step 208. The representative document images are displayed to the user on the display 24 in display step 212. In a preferable embodiment, the system accepts from the user input parameters upon which further search may continue in step 214. Search continues until the user chooses to discontinue 216.

In a related embodiment depicted in Fig. 3B, a compressed representation of each document image is made available in the database. Features are extracted from these compressed representations in an extraction step 207 before grouping step 208. Search proceeds with grouping step 208 as in the prior embodiment.

Another related embodiment also includes the step of permitting the user to choose the number of clusters desired before the first grouping step 208, or at any time while navigating the database prior to a new application of the grouping step.

Figs. 4-8 demonstrate the use of image processing techniques of compression, Fig. 4; features extraction, Fig. 5, 6, 7 and 8; and grouping, Fig. 9 which form the basis of the search technique.

Fig. 10 depicts the use of a web browser to

implement the display and user interface portions of the invention.

Compression Techniques

Compression reduces the cost of storing large quantities of document images in a database. Each document image is compressed via a compression technique such as wavelet compression (see e.g. IEEE Data Compression Conference, CREW: Compression with Reversible Embedded Wavelets, March 1995, which is incorporated herein by reference in its entirety for all purposes), or other techniques for compression known in the art.

Fig. 4 is illustrative of wavelet compression, which operates by recursively applying a pyramidal transform to the image data 402, dividing the image into high frequency information 404 and low frequency information 406. CREW has several advantages in this application. It decomposes an image into high and low pass components relatively quickly. It gives a lossy compression of 20:1, with minimal noticeable image degradation. Finally, it produces a low-pass sub-band image 412 in the upper left hand corner of the low-frequency quadrant. The sub-band image provides a recognizable iconic

representation of the document. This visually recognizable version of the document can be efficiently accessed and is useful as an index to the document information.

Fig. 5 is illustrative of the splitting off of low frequency image information 502 and high frequency image information 504 in one embodiment of the invention to extract different image features 506, 508. A document image in binary format 500 is acted upon by a 5 x 5 Gaussian smoothing filter in processing step 501 to yield a grayscale representation of the document image 502. Wavelength compression algorithm 503 is used to transform grayscale representation 502 into a compressed representation 504. Low-pass filter step 505 separates low frequency image information 506 from the compressed image representation 504. Analogously, high-pass filter step 509 separates high frequency image information 510 from the compressed image representation 504. Features extraction step 507 performed on the low frequency image information 506 yields the mean pixel value and the variance of the pixel values features 508. Analogously features extraction step 511 performed on the high frequency image information 510 yields the number of words,

number of pictures, and number of columns features 512. The low frequency and high frequency feature information is amalgamated together in step 513 to produce a feature vector 514.

In one embodiment of the invention, the low pass component of an image 410 is used as an icon for indexing into document image databases.

Feature Extraction

Feature extraction on the low frequency image information resulting from the compression yields the statistical moments of the image pixel values as depicted in Fig. 6. In one particular embodiment of the invention, the mean 602 and variance 604 of the pixel values are the statistical moments which are calculated from low frequency information according to the following formulas:

$$X_{mean} = \frac{1}{N}\sum X_j$$

and,

$$X_{variance} = \frac{1}{(N-1)}\sum (X_j - X_{mean})^2$$

wherein X_j is the value of each pixel in the low frequency document image.

Figs. 7 and 8 are illustrative of features

extraction applied to the high frequency image information resulting from the compression step. Connected components are extracted. In one particular embodiment of the invention, the features of total number of text words 702, pictures 704 and text columns 802, are extracted from the high frequency image information. Features extraction on the high frequency image information is done by looking for connected components. The first step in processing is to perform a histogram equalization, in which the minimum and maximum gray values are calculated, then their range is adjusted to have values between 0 and 255. Histogram equalization is a standard image procedure technique well known to persons of ordinary skill in the art. Finally, a connected component algorithm, which in the preferred embodiment is a four-connected component algorithm, is applied to the image information.

According to a four-connected component algorithm, processing of image data is done by looking at the four sides of a particular pixel for other pixels of similar gray level in searching for connected components. Pixels adjacent to the pixel under study at any of the four sites are aggregated together to form a connected component. By contrast,

an eight-connected component algorithm would look not only to the four sides of a pixel, but also to pixels adjacent at any of the four vertices of a pixel in locating connected components.

Once connected components have been identified, features such as the total number of text words 702, pictures 704 and text columns 802, may be extracted from the connected component information. The feature of total number of text words is determined by examining the total number of connected components below a certain threshold size. The threshold value is set to discern connected components which belong to text as from connected component regions which are associated with pictures. The count of connected components below the threshold is the number of words. The count of the connected components exceeding the threshold is the number of pictures.

Fig. 8 depicts the processing underlying the determination of the number of columns of text. A plot of connected components (y-axis) vs. locations (x-axis) is depicted in Fig. 8 graph 804. Plot 802 in Fig. 8 depicts the number of transitions in graph 804 (y-axis) vs. the number of connected components (x-axis). In the plot designated by 802, the number of

transitions is indicative of the number of columns in the image.

From observing the dominant plateaus in graph 802, it is possible to determine the predominant number of columns in a document. In the case of 802, the large picture causes this to be a predominantly one column document. However, the second plateau indicates that three columns are also present in the document. The peak detected at some high number indicates the word boundary noise, beyond this point no further column information can be extracted.

Grouping Document Images into Clusters

Document images are grouped together based upon feature information to form clusters of document images, each cluster containing document images having similar feature characteristics. One method of performing grouping is to employ a k-means algorithm. In one embodiment of the invention depicted in Fig. 9, grouping of images is performed into a selected number of groups 902, 904, 905. The desired number of groups may be chosen by the user, based upon the user's preference for granularity in the search vs the number of groups the user can track without promoting confusion. Grouping can be performed recursively on

the documents within any group, forming a hierarchical organization in the database.

Displaying a Representative Document Image

A representative document image for display to the user is automatically selected by the system from each cluster of documents images. In one embodiment of the invention, a center is calculated and the nearest image to that center is labeled as the characteristic image for each cluster generated by the grouping step. In a preferred embodiment of the invention, a web browser is used as the user interface for displaying document image representations and permitting the user to indicate which document image cluster should serve as the basis of further searching. As depicted in Fig. 10, a compressed representation of each representative document image is displayed as an icon 1002 using a web browser 1004 as a user interface. A related embodiment displays non-compressed representative images. In a preferable embodiment, the user may select a particular cluster as the basis for further search by indicating to the system, with a mouse 38 or other input device, the representative document icon for the cluster which is to be the basis of further search 1006. Search

continues by applying the grouping step to the selected cluster of documents, sub-dividing this cluster into a new set of clusters 1008, each having a new representative document image. In an alternative embodiment non-compressed document images are displayed.

Searching the World Wide Web for Document Images

In a related embodiment, documents retrieved from World Wide Web search engines, e.g., Altavista or Infoseek, may be browsed using methods according to the invention. Users typically receive a multiplicity of documents from a multiplicity of different sources returned in response to a simple text-based query. It is difficult to determine which documents are actually of interest. However, users desirous of a particular type of document distinguishable by its visual appearance, e.g., a scientific paper that contains mostly two-column text, can quickly obtain only those documents using techniques according to the invention.

The invention has now been explained with reference to specific embodiments. Other embodiments will be apparent to those of ordinary skill in the art. It is therefore not intended that the invention

be limited, except as indicated by the appended claims.

WHAT IS CLAIMED IS

1. A method for searching a database containing a plurality of document images, each document image having a textual component, a compressed representation, and a non-compressed representation, for a particular document image, said method comprising the steps of:

accepting text from a user as a keyword to search;

searching the textual component of said document images for said keyword;

grouping document images having textual components which contain said keyword into a plurality of clusters of document images based upon processing of the compressed representation, or the non-compressed representation of the document images;

displaying, based on said processing, a representative document image for each cluster of the plurality of clusters of document images; and

accepting input from the user indicating a particular cluster of document images.

2. A method according to claim 1 wherein said compressed representation is generated from said document image by applying a CREW algorithm to said document image.

3. A method according to claim 1 or 2 wherein said processing of the image component in the grouping step comprises the steps of:

extracting image feature information about said particular document image; and

applying a clustering algorithm to said image feature information to form clusters of document images.

4. A method according to claim 3 wherein said clustering algorithm comprises a "k-means" clustering algorithm to form a plurality of clusters of document images.

5. A method according to claim 4 wherein said plurality of clusters consists of between 5 and 10 document images.

6. A method according to claim 3, 4 or 5 wherein said extracting step comprises computing statistical information for said particular document image.

7. A method according to claim 6 wherein said extracting step additionally comprises computing component connections for said particular document image.

8. A method according to any one of the preceding claims wherein said processing in the displaying step comprises calculating a center for each cluster of document images and selecting the nearest document image to said center as the representative document image.

9. A method according to any one of the preceding claims further comprising:

recursively applying the grouping, displaying and accepting input steps to form a hierarchical search pattern through the database.

10. A method according to any one of the preceding claims wherein said displaying step further comprises:

displaying said compressed representation of each representative document image using a web browser.

11. A method according to any one of the preceding claims wherein said displaying step further comprises:

displaying said representative document image using a web browser.

12. A method for organizing a plurality of document images in a database comprising the steps of:

compressing each particular document image in said plurality of document images;

extracting image feature information about said particular document image;

grouping said particular document images together to form clusters of document images;

selecting, based on processing, a representative document image for each particular cluster of document images; and

displaying each particular representative document image.

13. A method according to claim 12 wherein said compressing step comprises applying a CREW algorithm to said particular document image.

14. A method according to claim 12 or 13 wherein said extracting step comprises computing statistical information from said particular document image and extracting text keywords from textual information contained in said particular document image.

15. A method according to claim 14 wherein said extracting step additionally comprises computing component connections for said particular document image.

16. A method according to any one of claims 12 to 15 wherein said grouping step comprises a "k-means" clustering algorithm to form a plurality of representative document groups.

17. A method according to claim 16 wherein said plurality of clusters consists of between 5 and 10 document images.

18. A method according to any one of claims 12 to 17 wherein said processing in the selecting step comprises calculating a center for each cluster of document images and selecting the nearest document image to said center as the representative document image.

19. A method according to any one of claims 12 to 18 additionally comprising the step of accepting user input selecting a particular representative document image as a starting point for recursive application of the grouping, selecting, displaying and accepting to form a hierarchical search method.

20. A method according to any one of claims 12 to 18 wherein said displaying step comprises displaying said

compressed representation of each representative document image using a web browser.

21. A method according to any one of claims 12 to 19 wherein said displaying step comprises displaying said representative document image using a web browser.

22. A computer program product comprising:

code that accepts text from a user as a keyword to search;

code that searches a database of document images, each document image having a textual component and a compressed representation, for document images with textual components that contain said keyword;

code that groups document images together into clusters of document images based upon processing of the image component of said document images;

code that selects a representative document image for each cluster for display;

code that displays said representative document images selected; and

a computer readable storage medium for storing the codes.

23. The computer program product of claim 22 further comprising:

code that generates said compressed representation from said document image by applying a CREW algorithm to said document image.

24. The computer program product of claim 22 further comprising:

code that accepts user input selecting images from the database from the representative document images displayed for recursive search forming a hierarchical

organization of said document images.

25. The computer program product of claim 22 wherein said code that groups document images further comprises:

code that clusters document images into a plurality of clusters employing a "k-means" algorithm.

26. The computer program product of claim 25 wherein said plurality of clusters consists of between 5 and 10 document images.

27. The computer program product of claim 22 wherein said processing of the image component of said code that groups document images further comprises:

code that extracts image feature information from said image component of said document images.

28. The computer program product of claim 27 wherein said code that extracts image feature information further comprises code that computes statistical information and code that extracts connected component information.

29. The computer program product of claim 22 wherein said code that selects a representative document image comprises code that calculates a center for each cluster of document images and selects the nearest document image to said center as the representative document image.

30. The computer program product of claim 22 wherein said code that displays said representative document images selected comprises code that displays said compressed representations of said document images using a web browser interface.

31. The computer program product of claim 22 wherein said code that displays said representative document images selected comprises code that displays said document images using a web browser interface.

32. A document image database organizing system comprising:

an electronic storage unit that stores a document image database;

a display that displays document images;

a processor unit coupled to said electronic storage device and said display, said processor unit operative to:

compress document images;

extract image feature information about document images;

group document images together according to said image feature information extracted;

select a representative document image for each group formulated;

display said representative document image to a user; and

accept from said user commands to manipulate document images.

33. A method of searching a database substantially as hereinbefore described with reference to the accompanying drawings.

34. A computer system for storing and searching a database constructed and arranged to operate substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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Application No:	GB 9820556.0	**Examiner:**	Leslie Middleton
Claims searched:	1,12,32	**Date of search:**	25 February 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G4A (AUDB)

Int Cl (Ed.6): G06F 17/30

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	WO 95/12173 A3	(Teltech RNC)	
A	EP 0722145 A1	(IBM)	
A	EP 0631245 A2	(Xerox Corpn.)	
A	EP 0601759 A1	(Xerox Corpn.)	

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&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.